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Adaptation of Learning Strategies in Learning Objects for using Learning Styles

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Abstract

Adaptation is a key element in web based learning systems. The learning objects have become a fundamental element to develop educational contents for e-learning environments. In this paper we have used the learning styles theory and its relationship with the learning strategies to generate news learning sequences. Through the metadata can be identied the teaching strategies in learning objects. Prerequisites and concepts allow the content sequence. We define several semantic levels to automatically generate new learning sequences. Each semantic level is applied to different learning styles. We applied this functionality in an e-learning system based on ontology.

Keywords: Adaptation, Learning strategies, learning styles, learning objects, learning object's composition.

1. Introduction

In Rojas et al, 2008 we applied the obtained results of the extraction of learning styles in learning objects. Our proposal intends to improve either the possibilities to adapt the contents to the student preferences and assist the authors in the selection, development and composition of learning objects. In this paper we propose new learning sequences to adapt the learning objects according to the student's learning style.

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This article starts defining the general concepts of the learning styles, learning objects, learning strategies and the SIMBAD model. Finally we presented a complete description of how to generate new learning sequences from the composition graphs.

2. Learning Objects, learning Styles, Learning Strategies and Sinbad model

E-learning advances have meant that each new system design for teaching considers the contributions of pedagogical theory. The technology component of our work, make up the model Sinbad and learning objects. The pedagogical component is made by learning styles associated with the adaptation of content and teaching strategies related to the manner in the content presented.

2.1 Learning objects

The e-learning technology has proposed applications to support the learning process; one of them is learning objects technique. The IEEE in 2002 defined the learning objects in Learning Object Metadata, as "any other entity, digital or not, that can be used in the learning, the education or the formation process". Schreurs & Moreau 2006 also show that the learning process is the interaction of content in a sequence or series of steps, each entails the interaction of the individual contents of a block. A learning object is a composition or a scene with a set of blocks. Blocks, have learning content in small parts, consisting of learning content (text document) and a set of atomic learning objects which are small pieces of learning content (document text, figures, pictures, video, audio, animations, questions and answers). However, Zapata 2006 define the central objective of learning objects is to achieve the possibility that students and teachers can adapt the training resources in accordance with their training goals and learning, their interests, needs and styles learning and teaching .

2.2 Learning Styles:

The learning styles refer to the individual differences between persons when they are immersed in a learning process. The Kolb model 1984 or Experiential Learning Model, is based on the idea that the experiences are a previous requirement to acquire physical abilities, reflexive observation, abstract conceptualization and active experimentation. Honey and Munford in Alonso 1999, identified four learning styles based on Kolb s experience. They propose four learning styles (activists, reflectors, theorist and pragmatics). Honey & Alonso 1999, took the Honey and Mumford experience and brought it back to the academic world. The Honey-Alonso Learning Styles Questionnaire (CHAEA) is a result of the translation and adaptation of the Learning Styles Questionnaire (LSQ) in the Spanish Universities.

2.3 Learning Strategies

Several studies presented variations on how to define the sequence on instructional strategies for learning styles. Mödritscher 2007 suggests the division of methods in three categories: (1) by adapting the instructions themselves, (2) by adapting the teaching sequences and (3) by adaptation through the insertion of new instructions. Stash 2007 uses four types of elements of teaching strategies, such as activity, example, theory and practice. Each learning style is directed to one of these components. Activists are oriented to an activity, reflectors are oriented to an example; theoretical are oriented to a theory and pragmatics are oriented to the exercise. The sequence and their relationships with the components of learning objects are analyzed by Morales 2008, who defines two methods to organize the elements of learning objects, one called "pragmatic"

and other called "theoretical". For the "pragmatic" method the elements were added, first a Learning Resource Type with a value Simulation, Experiment then, Exercise, Problem Statement, and Narrative Text. For the method "theory" is the order Narrative Text, Problem Statement, Simulation, Experiment and Exercise. The "pragmatic" method is applicable to active and pragmatic styles and "theoretical" method is applicable to reflexive and theoretical styles.

2.4 Sinbad Model

SINBAD is a model of complex educational resources developed by "Telecom SudParis". It consists oin three models, i.e., the domain model, learner model and the resource model, that have a complementary interrelation to offer an environment of great semantic richness, focus on the student. To support adaptation in SINBAD Duitama 2005 define "… the learning system will dispose a set of alternatives composition graphs (an acyclic directed graph) depending on goals an profile of a particular learner". SIMBAD can describe complex resources, structured recursively by composing basic resources to use operators Alternate (ALT), Sequence (SEQ) and Parallel (PAR). SIMBAD can be seen as a generalization of SCORM.

3. Adaptation of Learning Strategies for learning Styles

Following the application of learning styles and teaching strategies on learning objects, a group of sequences is applied during the learning process.

3.1 Sequence of content suitable for instructional strategies

For this adaptation of the learning strategy, we consider two variables; the first is about of keeping the author's intention, expressed in the prerequisites. The second is about the concepts levels in the domain model. After obtaining the line graphs, we can apply certain rules to develop instructional strategies tailored to each learning style. These rules allow you to assign to each node the lineal graphs, some priorities that will create new arcs which together generate new sequences of content. The following rules are the way to enrich the proposed model and adapt to the learning style of the student, in addition to supporting the design and composition of learning objects.

3.2 Application of instructional strategies in OA

We propose a group of instructional strategies by learning style, based in the content sequence. We have defined three types of similar activity to those proposed by Stash (2007), but associated with the classical approach "theory - practice – exercise". On the other hand, as suggested Morales (2008), activities related to LOM e.g. "Learning Resource Type". An ideal instructional strategy for each learning style is presented in Table 1. To assign values for each "activity" we consider the above analysis of appropriate sequences of learning style. Consequently, each content will have a value 1, 2, 3 according to the appropriate order for each style. So, as for a pragmatic practical content has a value 2 and a theoretical content has a value 3. When developing the algorithm the practical content will be first to the theoretical content.

Table 1. Instructional strategy for learning styles

	Active	Reflexive	Theorist	Pragmatic
Theory	3	1	1	3
Practice	1	3	2	2
Exercise	2	2	3	1

3.3 Adaptation of learning objects using instructional strategies (sequence of content)

To adjust using the sequences we analyze the content of the composition graph to establish a linear sequence. That allows us to visualize the learning strategy and possible alternatives to it. At Table 2 We define an order of educational activities (theory, practice and exercises) for each learning style. These sequences are expressed In the Composition graphs. But it is not clear which is the most appropriate for each learning style. Therefore is necessary to use this composition graphs creating new ways of learning that do not change the intent of the author that may offer more options to students. To do this, you must convert the composition graphs in a linear graph, then assign values to each node in the graph, and later, generate new arcs that take into to the order of precedence for learning style. As a result we obtain a linear graph for each learning style.

3.4 Convert the Composition Graphs into lineal graphs

Here is the transformation of Composition Graph into lineal graphs using topological order. To do this, SINBAD considers the operators ALT and PAR as a node, while SEQ represents the arc between nodes. We need a graph where only the concepts and related arcs.

Let GC $(_x)$ = C_m SEQ (C_n PAR C_l)
GC$(_x)$ =*{* C_m, $PAR_{n,l}$, C_n, C_l *}*
GC$(_x)$ =*{*< C_m, $PAR_{n,l}$>, < $PAR_{n,l}$, C_n >, < $PAR_{n,l}$, C_l>*}*

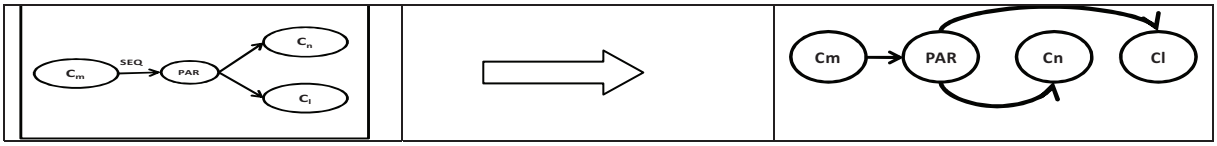

Fig. 1. Composition graph with operator PAR converted into a lineal graph.

To transform a lineal graph with operator PAR into a lineal graph without operator PAR, we proceed in the same way as for the delivering graphs in SINBAD model in Duitama 2005:

1. Let G be the composition graph of Ci
2. Result = Φ
3. Let S = G
4. WHILE ∃ Gi hasnodleast, a node $PAR_{a,b}$
5. S' = Φ
6. FOR each G_i in S
7. IF G_i has at least a node PAR as (<$PAR_{n,1}$, C_n>, <$PAR_{n,1}$, C_1>, <C_n, C_m>, <C_1, C_m>) and ¬∃ <C_x, $PAR_{n,1}$>
8. THEN G_i having arcs <C_n, C_m>, <C_1, C_m>
9. S' = S' ∪ G_i
10. ELSEIF G_i has at least a node PAR as (<C_m, $PAR_{n,1}$>, <$PAR_{n,1}$, C_n>, <$PAR_{n,1}$, C_1>)
11. THEN G_i having arcs <C_m, C_n>, <C_m, C_1>
12. S' = S' ∪ G_i
13. ELSE result = result ∪ G_i
14. END FOR
15. S = S'
16. END WHILE
17. result = result ∪ S

By applying this algorithm we have the following result, which has been eliminated ALT operator. It is clearly worthy that in the same way as we have abolished PAR operators, we can add them later.

Sea el GC$(_x)$ = (C_m SEQ C_n) (C_m SEQ C_l)
GC$(_x)$ =*{* C_m, C_n, C_l *}*
GC$(_x)$ =*{*< C_m, C_n >, < C_m, C_l>*}*

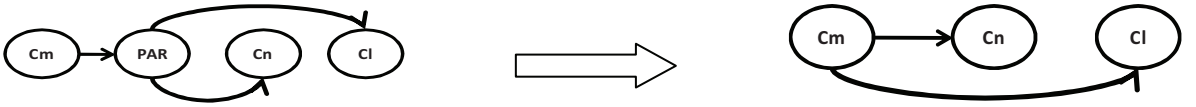

Fig. 2. Linear graph with operator PAR converted into a linear graph without operator PAR.

3.5 Adapting the sequence with the strategy established

3.5.1 Adapting the sequence with the strategy established by the author (use case 1)	**3.5.2 An adaptation of sequences based on the content structure (use case 2)**	**3.5.3 An adaptation of the sequence, respecting the content made by the author and the sequence of activities (use case 3)**
To do this, we must respect the semantics expressed through the prerequisites, i.e. we cannot change any sequence to establish a high priority on whether the preconditions of B are A, you do cannot change or delete A SEQ B. In the CG is preserved all nodes and arcs with prerequisites, and then create new arcs, in order of priority of educational activities. Determine if exists prerequisites, select the prerequisite concepts and prerequisites. Applying the prerequisites, we define the set of nodes as follows: Codes ={ Ci, Cj,…, Cn } Carcs ={< Ci, Cj>, …, < Cn-1, Cn>} Delete all arcs: Carcs = Φ IF Ci is PRE(Cj) THEN insert in Carcos the element < Ci, Cj> Create the PN= Cnodes IF < Ci, Cj> Carcs THEN delete in PN the element Cj Create the PN= Cnodes IF < Ci, Cj> Carcs THEN delete in PN the element Cj IF Ci, Cj PN and PAEA(Ci) = PAEA(Cj) THEN insert in Carcs the element < Ci, Cj> IF Ci, Cj PN and PAEA(Ci) = PAEA(Cj)+ 1 THEN insert in Carcs the element < Ci, Cj> IF Ci, Cj PN and PAEA(Ci) = PAEA(Cj)- 1 THEN insert in Carcs the element < Cj, Ci>	In this case, proceed to protect the contents of the domain and establish the sequence in terms of activities, namely the domain hierarchy to preserve and implement the priority of the activity. A graphic level, the nodes are preserved, and are in first place in the hierarchy of content, and then apply the priority of teaching activities. In this case the rules applicable in the following order: 1.Establishing precedence a. Domain content precedence b. Level domain precedence c. Educational activity precedence For each learning style generated a graph with weights for the educational activity. Cnodes ={ Ci, Cj,…, Cn } Carcs ={< Ci, Cj>, …, < Cn-1, Cn>} Delete all arcs : Carcs = Φ Create the PN= Cnodes IF CD(Ci) = CD(Cj) and PAEA(Ci) = PAEA(Cj) THEN insert in Carcs the element < Ci, Cj> IF CD(Ci) = CD(Cj) and PAEA(Ci) = PAEA(Cj)+ 1 THEN insert in Carcs the element < Ci, Cj> IF CD(Ci) = CD(Cj) and PAEA(Ci) = PAEA(Cj)- 1 THEN insert in Carcs the element < Cj, Ci>	This will keep all the content and apply according to the order of precedence of operations. It describes, in terms of graphs, it allows you to keep all nodes and all arcs are deleted. And given the priority activities will create new arcs. In this case the rules applicable in the following order: 1. Establishing precedence a. Educational activity precedence b. Domain content precedence Cnodes ={ Ci, Cj,…, Cn } Carcs ={< Ci, Cj>, …, < Cn-1, Cn>} Delete all arcs: Carcs = Φ Create the PN= Cnodes IF Ci, Cj PN and PAEA(Ci) = PAEA(Cj) THEN insert in Carcs the element < Ci, Cj> and delete Ci in PN IF Ci, Cj PN and PAEA(Ci) = PAEA(Cj)+ 1 THEN insert in Carcs the element < Ci, Cj> and delete Ci in PN IF Ci, Cj PN and PAEA(Ci) = PAEA(Cj)- 1 THEN insert in Carcs the element < Cj, Ci> and delete Ci in PN

4. Case of study

At next, we present an instructional design that allows showing the application of our proposal in a case study. Only show the first use case. That is where the prerequisites are maintained.

Table 2. Instructional design of the case study

Id	Prerequisites	Content
C1		<Algorithm, Example>, <Algorithm, Application>
C2		<Algorithm, Exercise>
C3	C1	<Algorithm, Definition>, <Flowcharts, Introduction><Flowcharts, Definition>
C4	C3	<Flowcharts, Exercise>, <Flowcharts, Conclusion>
C5		<Flowcharts, Description>,
C6	C5	<Flowcharts, Example>, <Flowcharts, Application>

Applying this algorithm in the use case described in Section 3, we must, and the resulting linear graph would be the following, then apply the criteria in order of activity and obtain a linear graph for each learning style. Figure 4 shows the resulting sequences for each style of learning through the use of use case 1. The continuous lines represent the formalities established by the authors and punctuated lines represent the arcs

created by the algorithm of use case 1. Inside each node appears the value to be assigned to indicate the order.

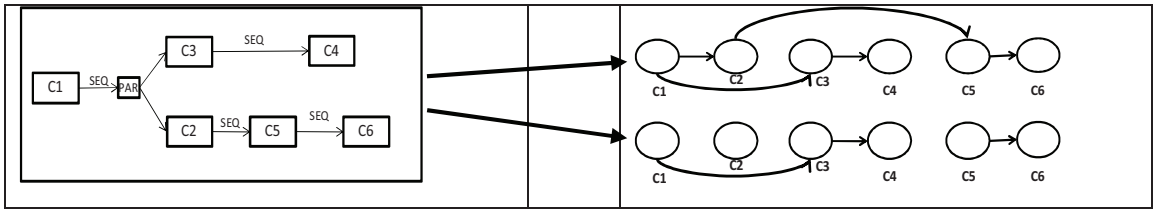

Fig. 3. Composition graph of the case study and two linear graphs resultants

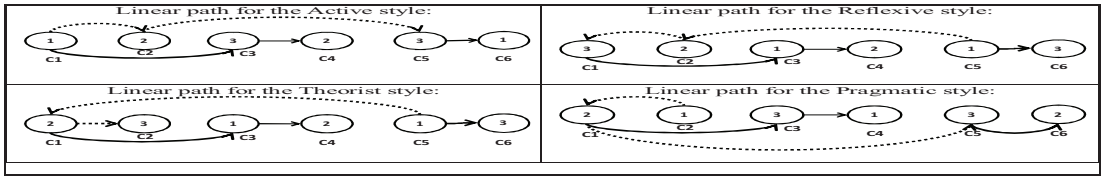

Fig. 4. Application of prerequisites precedence of learning styles.

5. Conclusions

The generation of different sequences of content increases the chance of finding an appropriate teaching strategy for student profile. Teaching strategies related to the way teachers teach. The automatic generation of different sequences of learning objects, based on the student's learning style, facilitates the work of design and composition of learning objects. The application of our proposal in SINBAD model allows completing the pedagogical dimension associated with learning strategies that is a coherent mode to extend the model by adding the student's individual differences. In future studies we will be able to obtain the student's navigation data taken from their interaction with a variety of learning sequences in different domains.

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